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Intensive care unit adaptations in the COVID-19 pandemic: Lessons learned

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Abstract

The coronavirus disease 2019 pandemic had deleterious effects on the healthcare systems around the world. To increase intensive care units (ICUs) bed capacities, multiple adaptations had to be made to increase surge capacity. In this editorial, we demonstrate the changes made by an ICU of a midwest community hospital in the United States. These changes included moving patients that used to be managed in the ICU to progressive care units, such as patients requiring non-invasive ventilation and high flow nasal cannula, ST-elevation myocardial infarction patients, and post-neurosurgery patients. Additionally, newer tactics were applied to the processes of assessing oxygen supply and demand, patient care rounds, and post-ICU monitoring.

Key Words: COVID-19; Pandemics; Oxygen; Intensive care units; ST elevation myo-

cardial infarction; Nasal cannula

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Core Tip: In this editorial, we demonstrate how the coronavirus disease 2019 pandemic changed our lives in the intensive care unit (ICU), especially in the management of surge capacity and allocation of resources in a 10-bed ICU of a United States suburban midwest community hospital. These strategies included managing complex patients in our progressive care unit, assessing oxygen supply and demand, performing patient care rounds, and post-ICU monitoring.

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INTRODUCTION

“Calamity tempestuous, oracle of destruction, ravishing through nations, ordained to devastation, negator of humanity, the annihilation of grace” is how our colleague depicted the coronavirus disease 2019 (COVID-19) pandemic in a recently authored poem[1]. The COVID-19 pandemic has wreaked havoc on healthcare systems all around the world[2,3]. To increase bed capacities and resources, elective surgeries were postponed[4]. Innovative approaches were implemented to perform virtual visits and perform patient care rounds[5,6]. Some hospitals have implemented structural modifications and changed strategies of resource allocation to face the intensive care unit (ICU) surge capacity and the sudden increased demand for invasive mechanical ventilation[7,8].

To meet the need for increasing demand for ICU beds, our staff at Mayo Clinic Health System (MCHS) in Mankato worked tirelessly to maximize our ICU capacity while maintaining high-quality patient care. MCHS Mankato is a 161-bed community hospital with a 15-bed multispecialty ICU staffed 24/7 by intensivists fellowship trained in critical care, a part of the Mayo Clinic enterprise in Southern Minnesota. A 19-bed progressive care unit (PCU) staffed by our hospitalist team manages patients with less acuity. Admission guidelines for both units are as per the Society of Critical Care Medicine admission criteria.

Over 80000 COVID-19 cases were diagnosed in Minnesota by September 2020[9]. Additionally, due to nationwide bed and staff shortages[2], we had to maximize our capacity to have an ICU literally without walls. Our multidisciplinary team determined that mitigation was required to overcome limited capacity[2,10,11]. Alterations to our daily routine had to be made with shared decision-making and increased communication across specialties[7]. In this editorial, we are providing a brief overview of these efforts and outcomes between November 2020 and December 2021.

PCU for do not resuscitate/do not intubate patients requiring noninvasive ventilation

Patients utilizing noninvasive ventilation (NIV) with do not resuscitate (DNR)/do not intubate (DNI) status were managed in the ICU prior to the pandemic. A collaboration between the critical care team, respiratory therapy, nursing, and hospitalist team was established to manage patients requiring NIV in the PCU. The Critical Care team managed the NIV, and the hospitalist group provided additional medical management. The challenges of this placement included a greater need for communication between very busy teams, and a potential urgent need for critical care beds if hemodynamic instability developed. Prior to November 2020, only 13 DNR/DNI patients were ever managed with NIV in the PCU. A total of 22 patients requiring NIV were managed during the last two months of 2020 (> 69.2% increase), with 79 total NIV patients being admitted to the PCU in 2021 (> 125.7% increase). This approach was found to be especially helpful for patients with prolonged respiratory failure, such as was seen with COVID-19[12,13].

ST-elevation myocardial infarction patients to the PCU

Prior to COVID-19, ST-elevation myocardial infarction (STEMI) patients were admitted to the ICU. Due to the need for more ICU beds, Critical Care, Cardiology, hospitalists, and nursing staff collaborated to manage hemodynamically stable STEMI patients in the PCU. A previous study showed that although > 80% of stable patients with STEMI are treated in the ICU after primary percutaneous coronary intervention, the risk for developing a complication requiring ICU care is 16%, which confirmed that

ICU was overutilized by stable STEMI patients[14]. Challenges to this approach included the necessity for enhanced cardiac education provided to the PCU nurses, increased requirement for more multidisciplinary coordination, and the urgent need for an ICU bed if hemodynamic instability occurs. After our adaptations, STEMI ICU admissions decreased from 107 (156 total STEMI cases) in 2020 to 51 (141 total STEMI cases) in 2021, a total reduction of 32.4%. There were no adverse events reported with this strategy.

Evaluating placement of post-operative neurosurgery patients

Before COVID-19, neurosurgical patients who underwent complex procedures were frequently managed post-operatively in the ICU regardless of hemodynamic stability. The neurosurgical and critical care teams implemented a collaborative process to assess each case for ICU appropriateness[15-17]. Those who did not need active ICU intervention (*e.g.*, pressors, intracranial monitoring, advanced oxygen therapy) were admitted to the PCU for management. Limitations of this approach included nurse training, the need for increased multidisciplinary collaboration, and the need for an emergent bed within the ICU if decompensation occurred. Prior to November, 28 of 61 post-operative neurosurgical patients were admitted to the ICU in 2020. From November 2020 through December 2020, 9 of 14 patients were managed in PCU. Sixty-two out of 109 post-operative neurosurgical cases were admitted to ICU in 2021.

High flow nasal cannula in PCU

Patients requiring greater than 0.60 FiO₂ using high flow nasal cannula (HFNC) were transferred to the ICU prior to November 2020. It was determined that all HFNC patients, regardless of code status or FiO₂ requirement, would be managed in the PCU unless the additional need for ICU admission occurred[18-20]. Nursing, respiratory therapy, and provider comfort were initial challenges. Before November 2020, 71 patients were managed in the PCU with HFNC requiring less than 0.6 FiO₂. From November 2020 until the end of 2021, a total of 187 patients were treated in PCU with HFNC, an increase of 116%. Many COVID-19 cases required prolonged HFNC without additional adjunctive critical care management, which opened ICU beds for patients requiring more complex support such as invasive mechanical ventilation[19,21].

Oxygen supply/demand assessment

Due to fixed medical gas availability, daily meetings between the respiratory therapy and critical care teams were conducted to evaluate oxygen consumption and demand. A report created in the electronic medical record delivered real-time data regarding oxygen devices in use. Medical gas pressure alarm values alerted the team to wean oxygen or change the patient to an alternative oxygen-conserving device if the gas supply reached a critical level. During times when the hospital oxygen supply reached a critically low level, ICU physicians and respiratory therapists assessed all HFNC patients for judicious use. In appropriate cases, NIV was utilized temporarily to decrease oxygen consumption while working on alternative approaches to minimize use. Additional attention was given to shutting off oxygen devices when not in use. Other tools and criteria were developed to assess oxygen resources and distribution[22,23].

Collaborate team care rounds with social distancing and visitor restrictions

A multidisciplinary approach is necessary to manage critically ill patients, and daily team rounds are an essential component of the ICU routine. Many critically ill patients cannot make medical decisions and rely on family members for assistance. During the COVID-19 pandemic, this was complicated by visitor restrictions resulting in family members calling 24/7 to receive updates and to advocate for patients. Calls were often accompanied by emotions such as anger, guilt, fear, frustration, and sadness related to the inability to be at the bedside. For the patients being alone posed a higher risk of ICU delirium. A telemedicine approach was adopted to involve the patient's family and maintain social distancing between the interdisciplinary team members, including the physician, advanced practice provider, respiratory team, nurses, pharmacist, dietician, and therapists[6,24]. During rounds *via* conference call, each team member would give a progress update and present their plan of care for the day. The physician or advanced practice provider would then summarize the plan of care and answer any questions the family had. The family was encouraged to participate throughout the rounding process actively and stay on the line for the entire process, typically about 10 min per patient[6]. Prior to the pandemic, both patients and families participated in the ICU interdisciplinary team rounds which were always conducted at the bedside. Due to the risk of exposure, the need to conserve full personal protective equipment, and the restricted visitor policy this approach was adopted. We wanted the families to receive real-time updates and assessments from the entire interdisciplinary team. Our rounds were a small gesture to lessen the emotional burden and were valued by family members. The ICU team also arranged virtual zoom or other video calls with patients and their families daily to reduce the risk of ICU delirium.

Post-ICU monitoring

Prior to the COVID-19 pandemic, ICU patients were typically monitored for 24 h in the ICU after receiving substantial life support (*e.g.*, mechanical ventilation, vasopressors, continuous renal replacement therapy). In response to increased demand for critical care beds across midwest America, ICU patients were moved to lower acuity beds at the earliest appropriate opportunity. To prevent ICU readmissions, rapid response nurses and virtual ICU providers (Mayo Clinic Enhanced Critical Care) followed every critical care discharge for 48 h regardless of hospital location. This practice has been used in different ways and has proved to decrease ICU mortality and hospital length of stay[25,26]. With this intervention, the ICU readmission rate remained low at 2% much lower than national data. Additionally, this provided extra support to hospitalists and nurses unfamiliar with managing patients immediately following ICU-level care.

CONCLUSION

Despite the significant increase in acuity within the ICU, the multidisciplinary team maintained a total ICU mortality rate index of 0.92 and a COVID-19 mortality rate index of 0.37. The length of stay index for the total ICU population was 0.95 and 1.39 for patients diagnosed with COVID-19. These numbers are impressive as they were achieved despite ICU acuity increasing as more stable patients, such as hemodynamically intact STEMI and post-operative neurosurgical patients, were transitioned to PCU care. Each member of the multidisciplinary team was crucial to our success. By maximizing our ICU resources and capacity, these interventions allowed us to better serve our community. The COVID-19 pandemic is not the last crisis that the world will face. This is the time for the call to action for the institutions to have alternative innovative strategies and learn the lesson from their shortcomings during the COVID-19 pandemic. This narrative is a prelude to our efforts and may be beneficial to other hospitals in case of another crisis.

FOOTNOTES

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REFERENCES

- 1 Khan SA. Corona. *HCA Healthcare J Med* 2021; **2**: 6 [DOI: [10.36518/2689-0216.1377](https://doi.org/10.36518/2689-0216.1377)]
- 2 McCabe R, Schmit N, Christen P, D'Aeth JC, Løchen A, Rizmie D, Nayagam S, Miraldo M, Aylin P, Bottle A, Perez-Guzman PN, Ghani AC, Ferguson NM, White PJ, Hauck K. Adapting hospital capacity to meet changing demands during the COVID-19 pandemic. *BMC Med* 2020; **18**: 329 [PMID: [33066777](https://pubmed.ncbi.nlm.nih.gov/33066777/) DOI: [10.1186/s12916-020-01781-w](https://doi.org/10.1186/s12916-020-01781-w)]
- 3 Barasa EW, Ouma PO, Okiro EA. Assessing the hospital surge capacity of the Kenyan health system in the face of the COVID-19 pandemic. *PLoS One* 2020; **15**: e0236308 [PMID: [32687538](https://pubmed.ncbi.nlm.nih.gov/32687538/) DOI: [10.1371/journal.pone.0236308](https://doi.org/10.1371/journal.pone.0236308)]
- 4 Tonna JE, Hanson HA, Cohan JN, McCrum ML, Horns JJ, Brooke BS, Das R, Kelly BC, Campbell AJ, Hotelling J. Balancing revenue generation with capacity generation: case distribution, financial impact and hospital capacity changes

- from cancelling or resuming elective surgeries in the US during COVID-19. *BMC Health Serv Res* 2020; **20**: 1119 [PMID: 33272278 DOI: 10.1186/s12913-020-05975-z]
- 5 **Al-Tawfiq JA**, Al-Yami SS, Rigamonti D. Changes in healthcare managing COVID and non-COVID-19 patients during the pandemic: striking the balance. *Diagn Microbiol Infect Dis* 2020; **98**: 115147 [PMID: 32891957 DOI: 10.1016/j.diagmicrobio.2020.115147]
- 6 **Wang H**, Poehler JL, Ziegler JL, Weiler CC, Khan SA. Patient Care Rounds in the Intensive Care Unit During COVID-19. *Jt Comm J Qual Patient Saf* 2020; **46**: 600-601 [PMID: 32768306 DOI: 10.1016/j.jeq.2020.06.006]
- 7 **Griffin KM**, Karas MG, Ivascu NS, Lief L. Hospital Preparedness for COVID-19: A Practical Guide from a Critical Care Perspective. *Am J Respir Crit Care Med* 2020; **201**: 1337-1344 [PMID: 32298146 DOI: 10.1164/rccm.202004-1037CP]
- 8 **Cammarota G**, Ragazzoni L, Capuzzi F, Pulvirenti S, De Vita N, Santangelo E, Verdina F, Grossi F, Vaschetto R, Della Corte F. Critical Care Surge Capacity to Respond to the COVID-19 Pandemic in Italy: A Rapid and Affordable Solution in the Novara Hospital. *Prehosp Disaster Med* 2020; **35**: 431-433 [PMID: 32423513 DOI: 10.1017/S1049023X20000692]
- 9 **Department of Health**. Situation Update for COVID-19. [cited 11 October 2022]. Available from: <https://www.health.state.mn.us/diseases/coronavirus/stats/index.html>
- 10 **Tyrrell CSB**, Mytton OT, Gentry SV, Thomas-Meyer M, Allen JLY, Narula AA, McGrath B, Lupton M, Broadbent J, Ahmed A, Mavrodaris A, Abdul Pari AA. Managing intensive care admissions when there are not enough beds during the COVID-19 pandemic: a systematic review. *Thorax* 2021; **76**: 302-312 [PMID: 33334908 DOI: 10.1136/thoraxjnl-2020-215518]
- 11 **Bravata DM**, Perkins AJ, Myers LJ, Arling G, Zhang Y, Zillich AJ, Reese L, Dysangco A, Agarwal R, Myers J, Austin C, Sexson A, Leonard SJ, Dev S, Keyhani S. Association of Intensive Care Unit Patient Load and Demand With Mortality Rates in US Department of Veterans Affairs Hospitals During the COVID-19 Pandemic. *JAMA Netw Open* 2021; **4**: e2034266 [PMID: 33464319 DOI: 10.1001/jamanetworkopen.2020.34266]
- 12 **Franco C**, Facciolo N, Tonelli R, Dongilli R, Vianello A, Pisani L, Scala R, Malerba M, Carlucci A, Negri EA, Spoladore G, Arcaro G, Tillio PA, Lastoria C, Schifino G, Tabbi L, Guidelli L, Guaraldi G, Ranieri VM, Clini E, Nava S. Feasibility and clinical impact of out-of-ICU noninvasive respiratory support in patients with COVID-19-related pneumonia. *Eur Respir J* 2020; **56** [PMID: 32747398 DOI: 10.1183/13993003.02130-2020]
- 13 **Cammarota G**, Esposito T, Azzolina D, Cosentini R, Menzella F, Aliberti S, Coppadoro A, Bellani G, Foti G, Grasselli G, Cecconi M, Pesenti A, Vitacca M, Lawton T, Ranieri VM, Di Domenico SL, Resta O, Gidaro A, Potalivo A, Nardi G, Brusasco C, Tesoro S, Navalesi P, Vaschetto R, De Robertis E. Noninvasive respiratory support outside the intensive care unit for acute respiratory failure related to coronavirus-19 disease: a systematic review and meta-analysis. *Crit Care* 2021; **25**: 268 [PMID: 34330320 DOI: 10.1186/s13054-021-03697-0]
- 14 **Shavadia JS**, Chen AY, Fanaroff AC, de Lemos JA, Kontos MC, Wang TY. Intensive Care Utilization in Stable Patients With ST-Segment Elevation Myocardial Infarction Treated With Rapid Reperfusion. *JACC Cardiovasc Interv* 2019; **12**: 709-717 [PMID: 31000008 DOI: 10.1016/j.jcin.2019.01.230]
- 15 **Santafé Colomina M**, Arikian Abelló F, Sánchez Corral A, Ferrer Roca R. Optimization of the neurosurgical patient in Intensive Care. *Medicina Intensiva (English Edition)* 2019; **43**: 489-496 [DOI: 10.1016/j.medine.2019.02.005]
- 16 **Howard RS**, Kullmann DM, Hirsch NP. Admission to neurological intensive care: who, when, and why? *J Neurol Neurosurg Psychiatry* 2003; **74** Suppl 3: iii2-iii9 [PMID: 12933908 DOI: 10.1136/jnnp.74.suppl_3.iii2]
- 17 **de Almeida CC**, Boone MD, Laviv Y, Kasper BS, Chen CC, Kasper EM. The Utility of Routine Intensive Care Admission for Patients Undergoing Intracranial Neurosurgical Procedures: A Systematic Review. *Neurocrit Care* 2018; **28**: 35-42 [PMID: 28808901 DOI: 10.1007/s12028-017-0433-4]
- 18 **Zemach S**, Helviz Y, Shitrit M, Friedman R, Levin PD. The Use of High-Flow Nasal Cannula Oxygen Outside the ICU. *Respir Care* 2019; **64**: 1333-1342 [PMID: 31213571 DOI: 10.4187/respcare.06611]
- 19 **Xia J**, Zhang Y, Ni L, Chen L, Zhou C, Gao C, Wu X, Duan J, Xie J, Guo Q, Zhao J, Hu Y, Cheng Z, Zhan Q. High-Flow Nasal Oxygen in Coronavirus Disease 2019 Patients With Acute Hypoxemic Respiratory Failure: A Multicenter, Retrospective Cohort Study. *Crit Care Med* 2020; **48**: e1079-e1086 [PMID: 32826432 DOI: 10.1097/CCM.0000000000004558]
- 20 **Spoletini G**, Alotaibi M, Blasi F, Hill NS. Heated Humidified High-Flow Nasal Oxygen in Adults: Mechanisms of Action and Clinical Implications. *Chest* 2015; **148**: 253-261 [PMID: 25742321 DOI: 10.1378/chest.14-2871]
- 21 **Guy T**, Créac'hacdec A, Ricordel C, Salé A, Arnouat B, Bizet JL, Langelot M, Lineau C, Marquette D, Martin F, Lederlin M, Jouneau S. High-flow nasal oxygen: a safe, efficient treatment for COVID-19 patients not in an ICU. *Eur Respir J* 2020; **56** [PMID: 32859678 DOI: 10.1183/13993003.01154-2020]
- 22 **ASHE**. Medical Air and Oxygen Capacity Assessment Tool. 2020. [cited 11 July 2022]. Available from: <https://www.ashe.org/medical-air-and-oxygen-capacity-assessment-tool>
- 23 **World Health Organization**. Oxygen sources and distribution for COVID-19 treatment centres: interim guidance, 4 April 2020. [cited 18 June 2022]. Available from: <https://www.who.int/publications/i/item/oxygen-sources-and-distribution-for-covid-19-treatment-centres>
- 24 **Mangram AJ**, Mccauley T, Villarreal D, Berne J, Howard D, Dolly A, Norwood S. Families' perception of the value of timed daily "family rounds" in a trauma ICU. *Am Surg* 2005; **71**: 886-891 [PMID: 16468543]
- 25 **Lilly CM**, Thomas EJ. Tele-ICU: experience to date. *J Intensive Care Med* 2010; **25**: 16-22 [PMID: 19752038 DOI: 10.1177/0885066609349216]
- 26 **Udeh C**, Udeh B, Rahman N, Canfield C, Campbell J, Hata JS. Telemedicine/Virtual ICU: Where Are We and Where Are We Going? *Methodist Debaque Cardiovasc J* 2018; **14**: 126-133 [PMID: 29977469 DOI: 10.14797/mdcj-14-2-126]



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